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Technical expertise on the cause of final drive unit failure of the VAZ Niva

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ABSTRACT: *The article concerns the case of damaged front axle final drive unit of the VAZ Niva and the methodology a technical expert applied to identify a direct cause of failure. The final drive unit failure occurred when operating a vehicle after 22, 804 km service, the failure being manifested by oil leakage, damage to the crown wheel teeth and bevel gear pinion (pear-shaped), and damage to the shaft assembly bearings of conical gears. The above-mentioned failure had to be assessed by a technical expert to determine whether it had been caused by a material defect or occurred because of the mode of using the vehicle. To determine the cause, a vehicle has been inspected on the car service station premises, where a technical expert was present and according to his instructions, diagnostic and subsequent disassembly works were done. The procedure of evaluating the key characteristics on individual parts, their display and the resulting evaluation are described.*

KEYWORDS: *Vehicle, failure, final drive unit, differential, technical expertise*

I. INTRODUCTION

There are often vehicle failures in a real life where it is necessary to analyses and decide on how the failure occurred. For these reasons, technical experts also inspect damaged parts and they consequently analyses the mode of failure. In addition to their expertise, also the knowledge of similar cases they can familiarize themselves with through the publication of investigations and analyses already performed, contributes to the quality of their work. This procedure increases the beliefs of technical experts that their investigation and outcomes will not contradict the already known case. Here, the issue was the final drive unit of the VAZ Niva front axle, with mileage of 133, 085 km in total. The final drive unit failure occurred in operation, after 22, 804 km service and the replacement of a final drive, the failure being manifested by oil leakage, damage to the crown wheel teeth and bevel gear pinion (pear-shaped), and damage to the bearings of bevel gear shafts assembly. The technical expert´s task was after getting familiar with the type of damage of the final drive individual parts as well as the whole final drive unit to assess whether the failure occurred due to material defect or because of the way of using a vehicle. To determine the cause, a vehicle was on the car service station premises, where a technical expert was present and according to his instructions, diagnostic and subsequent disassembly works were done. All operations have been documented and recorded by a video camera.

II. VEHICLE DATA

Make: VAZ Niva 21214
Mileage: 133 061 km
Mileage after the final drive and differential installation: 22 804 km
Drive 4x4
A clear view of vehicle is shown in Fig.1

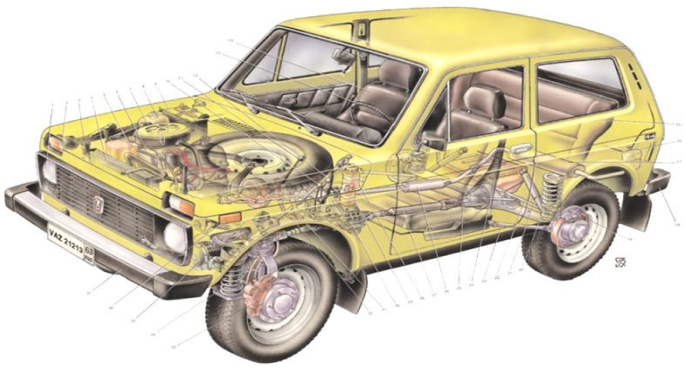


Figure 1: View of the VAZ Niva 21214 and the layout of its main parts

III. FINAL DRIVE UNIT AND DIFFERENTIAL- FUNCTION AND MECHANICAL DESIGN DESCRIPTION

A final drive unit is a transmission gear that transfers a torque to a drive axle wheels. It is a permanent gear and the differential is its part. Reducing the operating speed and distributing it on the drive wheels, the final drive enables to move your car. It is a part of the axle for the classic car concepts; with independent wheel suspension, a separate box is assembled on the bodyshell or chassis, in cars with the front-wheel drive (currently the most used concept), or with the rear engine and rear-wheel drive, the final drive is the part of a gearbox and is placed in a common cabinet with the clutch thus forming one assembly unit (drive unit) together with the engine.

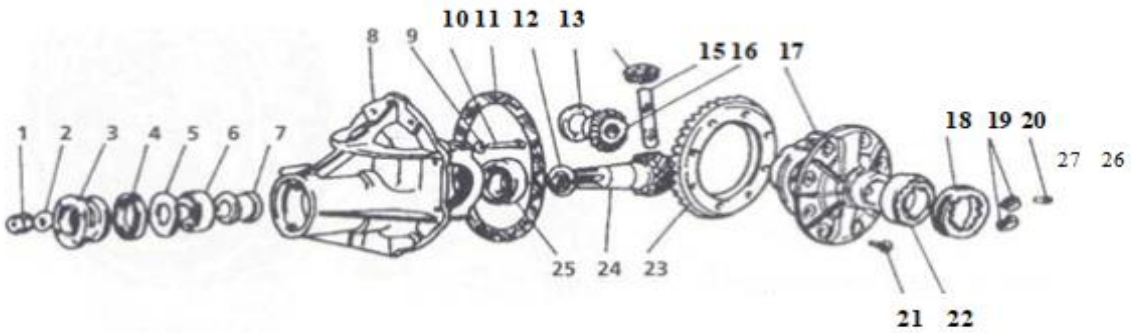
It consists of:

- Permanent drive axle gear
- Differential

The drive axle permanent gear is the gear, the job of which is to continuously increase the torque (reduce speed) and transfer it to both drive wheels.

The following types of a final drive unit are used in vehicles:

Final drive unit with single transaxle gears – consists of single conical, head or worm gears. It is formed of one pair of permanent gears as illustrated in Fig.



1 – pinion nut, 2 - washer, 3 – splined gripper, 4 – shaft ring, 5 – throw ring, 6 – external taper bearing, 7 – expander bush, 8 – final drive, 9 – spring washer, 10 – bolt, 11 – cover gasket of a final drive, 12 – thrust ring, 13 – spacer ring, 14-satellite disc, 15 – satellite pinion, 16 – planet wheel, 17 – differential lockbox, 18 – bearing threaded, 19 – safety washers, 20 - bolt, 21 – conical bearing, 22 - bolt, 23 – plate wheel, 24 – pinion shaft, 25 – internal bevel gear, 26 – spring washer, 27 - bolt

Figure 2: Classic final gear unit broken down into parts and their description

Bevel gears (bevel pinion (pear-shaped) + plate wheel) are illustrated in Fig.3

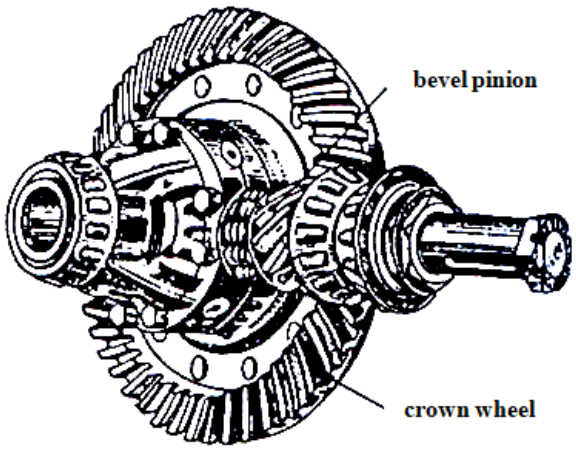


Figure 3: Bevel gears and description

Description of the Lada Niva 21214 4x4 axle drive and wheels: The Lada 21214 4x4 axles are powered through a gearbox and interaxle differential with a differential interlock via two articulated shafts (for front and rear axles), via axle distributors with differentials, half-axles up to axle wheels.

The drive is permanent, and the vehicle is equipped with the interaxle differential interlock operated by a lever from the driver´s seat to improve the trafficability of a vehicle as shown in Fig. 4.

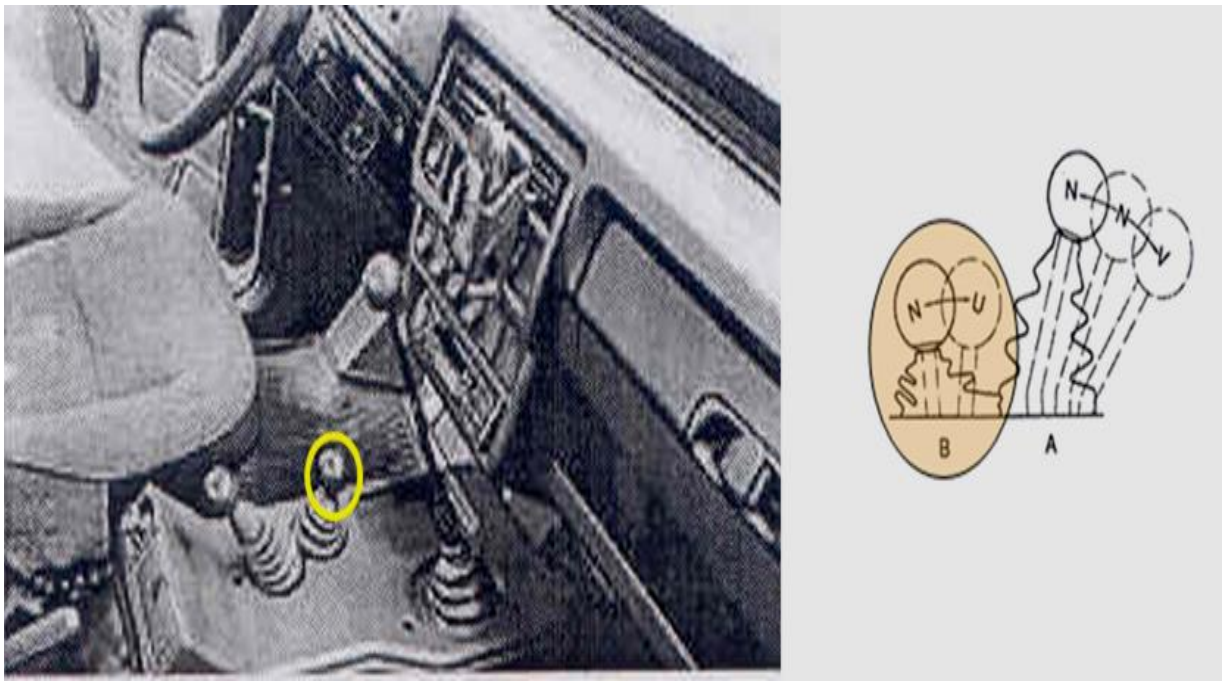


Figure 4: Differential interlock controls

The interlock can only be engaged in a challenging terrain and only for the most required time on a slow-moving vehicle. If changing gear is difficult, it is necessary to stop a vehicle and switch the gear.

The function of an interaxle differential:

It evenly distributes torques on to the driven axles.

The function of an interaxle differential interlock: It enhances the trafficability of a vehicle so that also the axle whose wheels have no contact with the terrain or move on the surface at a lower adhesion be driven.

IV. FINAL DRIVE UNIT INSPECTION

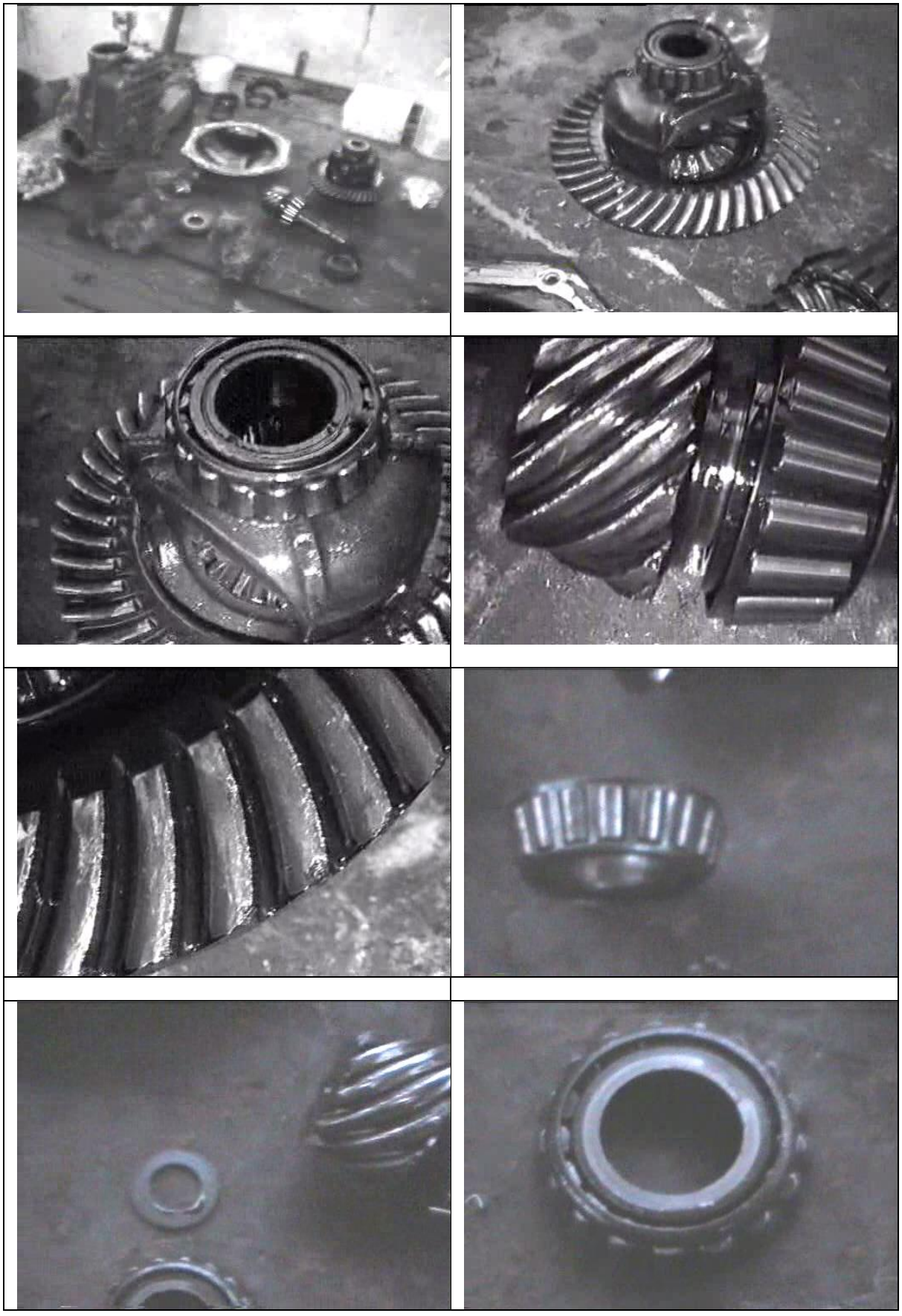
Place: a car service station

A video was recorded, and photographs were taken upon the inspection.

Inspection findings:

- A crown wheel: the displacement of all gear teeth in and out of engaging surfaces, changed geometric shape of all teeth
- Pinion (pear-shaped): the displacement of all gear teeth in and out of engaging surfaces, changed geometric shape of all teeth
- Bevel gear shaft bearings: blue-coloured surfaces, traces on the taper roller bearings
- A ring for setting the pinion (pear-shaped) contact with a plate wheel – not damaged

The photographs taken upon the inspection are in Fig. 5.



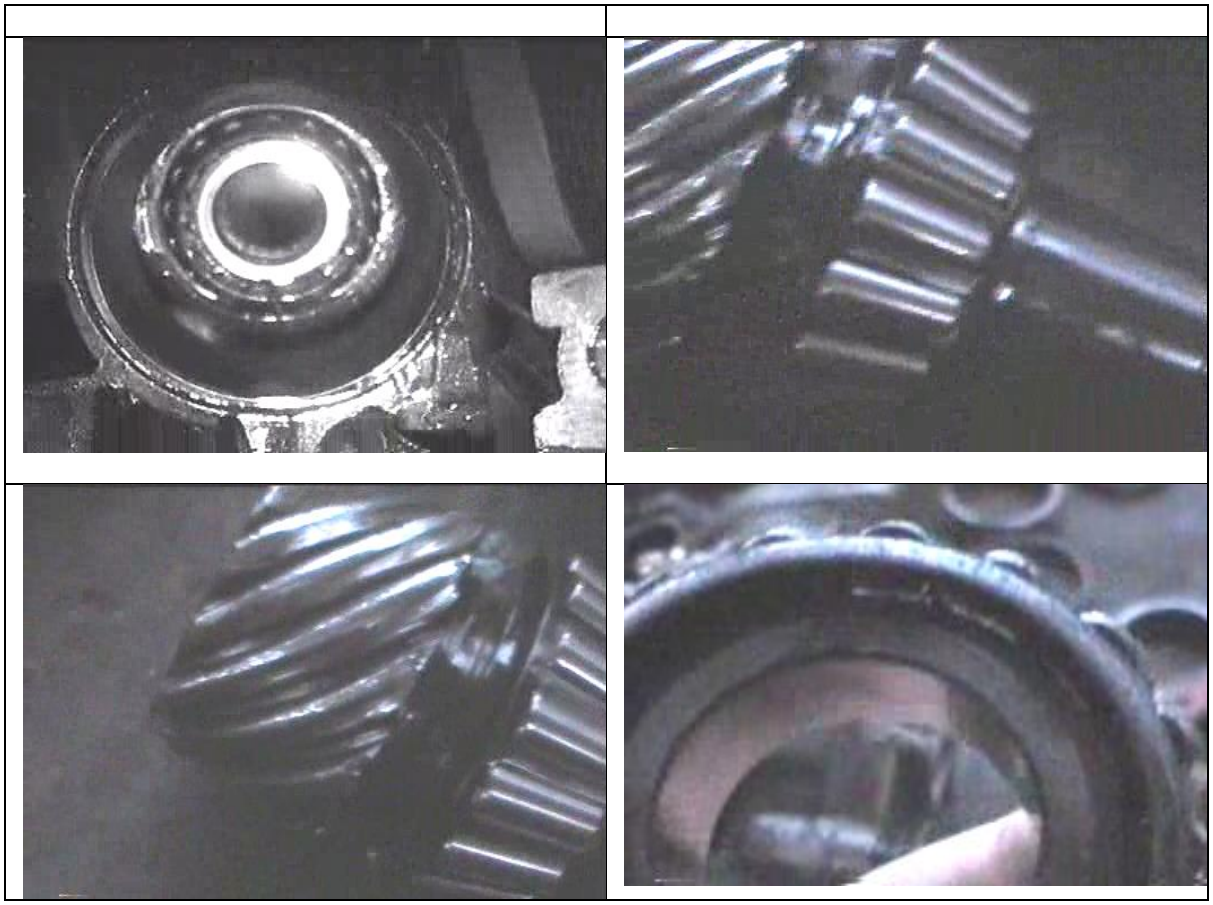


Figure 5: Photographs of the damaged parts -differential

V. DAMAGE EVALUATION

1. crown wheel: the displacement of all teeth of the crown wheel in and out of engaging surfaces, changed geometric shape of all teeth; changed geometric shape occurred mainly out of teeth active surfaces at their profile upper part, where an oblique imprint of counter clockwise wheel teeth was detected - Fig. 6.
2. Pinion (pear-shaped): the displacement of all teeth of the crown wheel in and out of engaging surfaces, changed geometric shape of all teeth; changed geometric shape occurred mainly out of teeth active surfaces at their profile upper part, where an oblique imprint of counter clockwise wheel teeth was detected– Fig.7.
3. bevel gear shaft bearings: blue-colored surfaces, traces on the taper roller bearings.

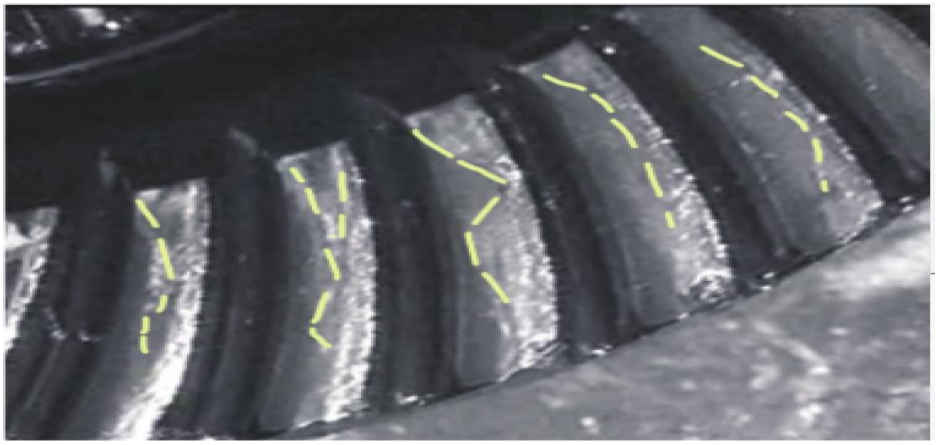


Figure 6: Damage to the crown wheel teeth- marked

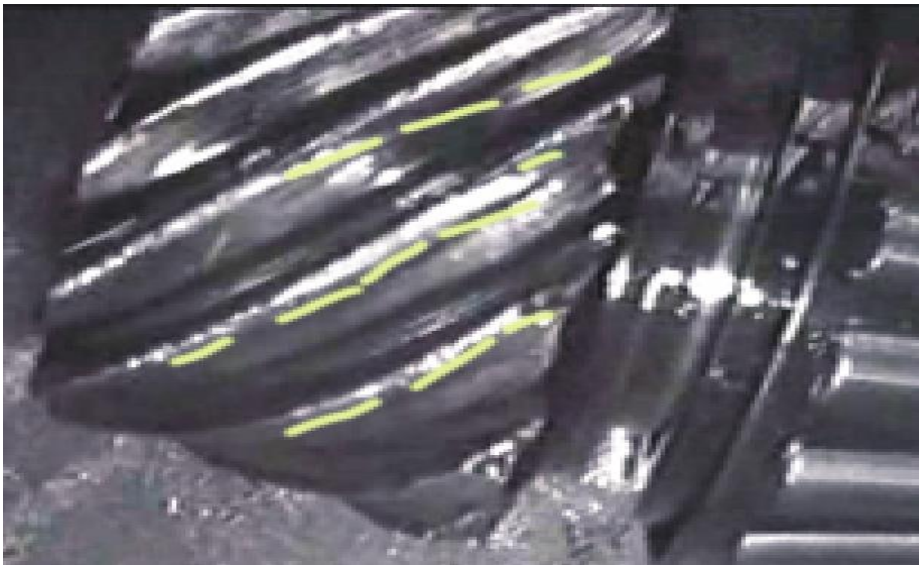


Figure 7: Damage to the pinion teeth- marked

VI. CONSEQUENCES OF DRIVING WITH LOCKED INTER-AXLE DIFFERENTIAL

The use of inter-axle differential interlock is only allowed for a short-term drive in a challenging terrain.

Driving with locked inter-axle differential for a long time would result in:

- uniform torque distribution onto both axles, i. e without the possibility to distribute it when driving at a higher speed and for a long time thus:
- increased pressure on the toothed bevel gear (bevel pinion (pear-shaped) + crown wheel) in the case of different surface conditions under front and rear axles or in cornering
- increased wear of the gear working surfaces
- changes in relative positions of bevel gear wheels – pinion movements towards the crown wheel
- possible damage to the shaft sealing elements (spring- energised seals)
- possible oil leakage
- possible damage to the shaft bearings assembly
- further change in the relative positions of bevel gear wheels – pinion off-axis movements
- changed geometric shape of the bevel gear wheel teeth

VII. CONCLUSIONS

The consequences of long-distance driving with the locked inter-axle differential described in Section 6, corresponds with findings on the Lada Niva 21214 damaged differential to the extent that leads to a technical conclusion the identified damage to the bevel gear of the above-mentioned vehicle occurred because of frequent or long-term driving with the inter-axle differential locked up. Such mode of driving is inconsistent with instructions for driving a vehicle, therefore, we can state that a failure in question has occurred due to improper use of a vehicle by the driver.

REFERENCES

1. Ing. František Vlk, DrSc.: Koncepce motorových vozidel (Concept of motor vehicles), 1. vydanie, Brno 2000
2. Company specialist literature

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